

Genetics Problems

BASIC

1. What combination of gametes would be produced by organisms having the following genotypes:

a) Aa	c) AABB
b) AaBB	d) AaBb
2. If 'T' represents tall, and 't' represents dwarf, what will be the phenotype of the offspring in the following crosses:

a) Tt x tt	c) Tt x Tt
b) TT x Tt	d) TT x tt
3. A tall plant is crossed with a dwarf one and produces offspring of which half are tall and half are dwarf. What are the genotypes of the parents?
4. If the tall parent in problem 3 is self fertilized (ie. crossed with itself), what percentage of the offspring will be tall? Dwarf?
5. If brown eyes (B), are dominant to blue eyes (b), what eye colour will the children have from a cross between a homozygous brown eyed man and a heterozygous brown eyed woman?
6. A blue eyed man, whose parents were both brown eyed, marries a brown eyed woman. They have one child who is blue eyed. Use a pedigree chart to show the genotypes of all individuals.
7. For Labrador retrievers, black fur color is dominant to yellow. Explain how a homozygous black dog can have a different genotype than a heterozygous black dog. Could the heterozygous black dog have the same genotype as a yellow-haired dog?
8. A pea plant with round seeds is cross-pollinated with a pea plant that has wrinkled seeds. For the cross, indicated each of the following:
 - a) the genotypes of the parents if the round-seed plant was heterozygous
 - b) the gametes produced by the round and wrinkled-seed parents
 - c) the genotypes and the phenotypes of the F₁ generation
9. For Dalmatian dogs, the spotted condition is dominant to non-spotted.
 - a) Using a Punnett square, show the cross between two heterozygous parents.
 - b) A spotted female Dalmatian dog mates with an unknown father. From the appearance of the pups, the owner concludes that the male was a Dalmatian. The owner notes that the female had six pups, three spotted and three non-spotted. What is the phenotype of the unknown male?

10. For Mexican hairless dogs, the hairless condition is dominant to hairy. A litter of eight pups is found, six are hairless and two are hairy. What is the genotype of their parents?
11. In cattle, polled (hornless) = P, horned = p. Determine the genotypes of the four parents and the offspring of the following matings. A polled bull is bred with three different cows:
- a) cow A is horned and produces a polled calf
 - b) cow B is horned and produces a horned calf
 - c) cow C is polled and produces a horned calf

TEST CROSS

1. If a farmer has a tall pea plant and wants to determine if it is heterozygous tall or homozygous tall, what should he do?

MULTIPLE ALLELES

1. Multiple alleles control the intensity of pigment in mice. The gene D^1 designates full color, D^2 designates dilute color, and D^3 is deadly when homozygous. The order of dominance is $D^1 > D^2 > D^3$. When a full-color male is mated to a dilute-color female, the offspring are produced in the following ratio: two full color to one dilute to one dead. Indicate the genotypes of the parents.
2. Multiple alleles control the coat color of rabbits. A gray color is produced by the dominant allele C . The C^{ch} allele produces a silver-gray color when present in the homozygous condition, $C^{ch}C^{ch}$, called chinchilla. When is present with a recessive gene, a light silver-gray color is produced. The allele C^h is recessive to both the full-color allele and the chinchilla allele. The C^h allele produces a white color with black extremities. This coloration pattern is called Himalayan. An allele C^a is recessive to all genes. The C^a allele results in a lack of pigment, called albino. The dominance hierarchy is $C > C^{ch} > C^h > C^a$. The table below provides the possible genotypes and phenotypes for coat color in rabbits. Notice that four genotypes are possible for full-color but only one for albino.

Phenotypes	Genotypes
Full Color	CC, CC^{ch}, CC^h, CC^a
Chinchilla	$C^{ch}C^{ch}$
Light gray	$C^{ch}C^h, C^{ch}C^a$
Himalaya	C^hC^h, C^hC^a
Albino	C^aC^a

- a) Indicate the genotypes and phenotypes of the F_1 generation from the mating of a heterozygous Himalayan-coat rabbit with an albino-coat rabbit.
- b) The mating of a full-color rabbit with a light-gray rabbit produces two full-color offspring, one light-gray offspring, and one albino offspring. Indicate the genotypes of the parents.
- c) A chinchilla-color rabbit is mated with a light-gray rabbit. The breeder knows that the light—gray rabbit had an albino mother. Indicate the genotypes and phenotypes of the F_1 generation from this mating.

INCOMPLETE DOMINANCE

1. In four-o'clock flowers neither red nor white flower colour is dominant or recessive. Hybrid flowers are pink. In the following crosses, what will be the flower colour of the offspring?
 - a) $RW \times RR$
 - b) $WW \times RR$
 - c) $RR \times RW$
 - d) $RW \times RW$
2.
 - a) If a red-flowered four o'clock is crossed with a white-flowered four o'clock, what will be the flower colour of the F_1 generation?
 - b) When the F_1 is crossed with the F_1 , the F_2 generation is produced. What is the ratio of flower colours in the F_2 ?
3. A geneticist notes that crossing a round-shaped radish with a long-shaped radish produces oval-shaped radishes. If oval radishes are crossed with oval radishes, the following phenotypes are noted in the F_2 generation: 100 long, 200 oval, and 100 round radishes. Use symbols to explain the results obtained for the F_1 and F_2 generations.
4. Palomino horses are known to be caused by the interaction of two different genes. The allele C^r in the homozygous condition produces a chestnut, or reddish-color horse. The allele C^m produces a very pale cream coat color, called cremello, in the homozygous condition. The palomino color is caused by the interaction of both the chestnut and cremello alleles. Indicate the expected ratios in the F_1 generation from mating a palomino with a cremello.

DIHYBRID CROSSES

1. In pea plants: tall (T) is dominant over dwarf (t), and yellow seeds (Y) are dominant over green (y).
 - a) Using a Punnett Square, represent a cross between a homozygous dwarf plant with green seeds, and a heterozygous tall plant with yellow seeds.
 - b) State the expected genotypes and phenotypes from this cross.
2. Show the expected genotypes and phenotypes from a cross between two heterozygous tall, heterozygous yellow pea plants. What fraction of the offspring are dwarf with green seeds?
3. In guinea pigs black hair (B) is dominant to brown hair (b), and short hair (S) is dominant to long hair (s). What is the expected ratio of genotypes and phenotypes in a cross between a homozygous long-black guinea pig and one heterozygous for short black hair?

4. In a type of primrose plant, the red flower (R) shows incomplete dominance to the white (W), while tallness (T) and shortness (t) segregated independently (the traits are not blended). Show the offspring of the cross between a pure red tall plant and a pure white short plant (this is the F₁ generation). What percentage of the F₂ will be pink short?
5. The chestnut color (b) of a horse is due to a recessive gene while the dominant allele results in black (B). The pacing gait is due to a recessive gene (t) whereas the dominant allele results in the trotting gait (T). Show the types of offspring which would result from a cross between a black trotter (heterozygous for both traits) and a chestnut pacer.
6. In guinea pigs, black coat color (B) is dominant to white (b), and short hair length (S) is dominant to long (s). Indicate the genotypes and phenotypes from the following crosses:
 - a) Homozygous for black, heterozygous for short-hair guinea pig crossed with a white, long-hair guinea pig.
 - b) Heterozygous for black and short-hair guinea pig crossed with a white, long-haired guinea pig.
 - c) Homozygous for black and long-hair crossed with a heterozygous black and short-hair guinea pig.
7. Black coat color (B) in cocker spaniels is dominant to white coat color (b). Solid coat pattern (S) is dominant to spotted pattern (s). The pattern arrangement is located on a different chromosome than the one for color, and its gene segregates independently of the color gene. A male that is black with a solid pattern mates with three females. The mating with female A, which is white solid, produces 4 pups: 2 black solid, and 2 white solid. The mating with female B, which is black solid, produces a single pup which is white spotted. The mating with female C, which is white spotted, produces four pups: one white solid; one white spotted; one black solid; one black spotted. Indicate the genotypes of the parents.

BLOOD

1. A mother of blood type A and a father of blood type B had a child with blood type O. Show all of their genotypes.
2. Mrs. Doe and Mrs. Roe had babies at the same hospital at the same time. Mrs. Doe took home a girl named Iris. Mrs. Roe took home a girl named Mary. However, there was a question as to whether the babies were switched. Determine if this happened.

Mrs. Doe – type B
 Mr. Doe – type B
 Mrs. Roe – type AB

Mr. Roe – type O
 Iris – type A
 Mary – type O

3. For human blood type, the alleles for types A and B are codominant, but both are dominant over the type O allele. The Rh factor is separate from the ABO blood group and is located on a separate chromosome. The Rh⁺ allele is dominant to Rh⁻. Indicate the possible phenotypes from the mating of a woman, type O, Rh⁻, with a man, type A, Rh⁺.